

QUIZ NAVIGATION

	Rose Wang
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Started on	Tuesday, 15 October 2024, 3:29 AM
State	Finished
Completed on	Tuesday, 15 October 2024, 3:35 AM
Time taken	6 mins 23 secs
Marks	6.0/9.0
Grade	66.7 out of 100.0

Question 1

ID: 54386

Correct

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THE NEXT 4 QUESTIONS REFER TO THE FOLLOWING CASE:

EP is a 76 year old female who has been seen at the kidney care clinic every 3 months. Her current eGFR is stable at 19 ml/min and her creatinine 566 mmol/L.

Past medical history: type 2 diabetes, hypertension, dyslipidemia, gout, GERD, osteoarthritis, cerebrovascular accident, previous back injury secondary to a motor vehicle accident, and diabetic neuropathy.

Current medications include:

- Clopidogrel 75 mg daily
- Allopurinol 100 mg daily
- Ramipril 10 mg daily
- Bisoprolol 5 mg daily
- Ferrous fumarate 900 mg qhs
- Rosuvastatin 20 mg daily
- Furosemide 40 mg BID
- Amlodipine 10 mg daily
- Ranitidine 150 mg daily
- Acetaminophen 325 mg PRN
- Insulin glargine 25 units qhs
- Insulin lispro 20 units TID

EP states that she is not feeling well since eating at a picnic yesterday; she is vomiting, has diarrhea, and is unable to keep food down.

The most appropriate plan for EP is to:

Select one:

Continue all her medications and monitor blood pressure

Continue all medications but reduce insulin lispro to 10 units TID

Hold ramipril and furosemide until vomiting and diarrhea resolve

Rose Wang (ID:113212) this answer is correct. Ramipril and furosemide can both lead to acute kidney failure in patients who are dehydrated.

Hold furosemide and insulin glargine until vomiting and diarrhea resolve

Correct

Marks for this submission: 1.0/1.0.

TOPIC: Chronic Kidney Disease

LEARNING OBJECTIVE:

To identify and minimize the risks for acute renal failure.

BACKGROUND:

Chronic kidney disease (CKD) is defined by the presence of kidney damage or a decrease in kidney function lasting for at least three months. The first sign of CKD is often a reduction in creatinine clearance and/or proteinuria. The staging of CKD is as follows:

CKD Staging

Kidney Function Stage	eGFR (ml/min/1.73m ²)
G1 - normal or high	≥90
G2 – Mildly decreased	60 - 89
G3a – Mildly to moderately decreased	45 - 59
G3b – moderately to severely decreased	30 - 44
G4 – severely decreased	15 - 29
G5 – kidney failure	<15 or on dialysis

Albuminuria Stage

Albuminuria (mg/mmol)

A1	<3
A2	3 - 30
A3	>30

Other changes in bloodwork include:

- Decreased hemoglobin, hematocrit, and ferritin
- Decreased calcium
- Decreased bicarbonate (i.e. a shift towards metabolic acidosis)
- Increased phosphate
- Increased potassium

Symptoms often begin to appear at stage G3b. Symptoms initially are mild but can progress and become severe as kidney function continues to drop. Symptoms include:

- Confusion
- Lack of energy
- Pruritis
- Lack of appetite
- Edema
- Lack of urination
- Nausea (in severe CKD)

There is a list of medication which increases the risk of renal failure if taken while in a dehydrated state, known as SADMANS:

- Sulfonylureas
- Angiotensin enzyme inhibitors (ACEi)
- Diuretics
- Metformin
- Angiotensin receptor blockers (ARBs)
- Non-steroidal anti-inflammatory drugs (NSAIDs)
- Sodium glucose linked transporter 2 (SGLT2) inhibitors

RATIONALE:

Correct Answer:

- Ramipril and furosemide can both lead to acute kidney failure in patients who are dehydrated.** - Ramipril and furosemide can both lead to acute kidney failure in patients who are dehydrated.

Incorrect Answers:

- Continuing all medications and monitor blood pressure** - Continuing all medications and monitor blood pressure is not an ideal plan of action.
- Continuing all medications but reducing insulin lispro to 10 units TID** - Continuing all medications but reducing insulin lispro to 10 units TID is not the safest plan for EP.
- Holding furosemide and insulin glargine** - Holding furosemide and insulin glargine is not the safest plan for EP.

TAKEAWAY KEY POINTS:

SADMANS is an acronym referring to the list of medications that should be stopped when someone is sick or severely dehydrated.

REFERENCE:

- [1] KDIGO 2017 clinical practice guideline update for the diagnosis, evaluation, prevention, and treatment of chronic kidney disease – mineral and bone disorder (CKD-MBD). *Kidney International Supplements*. 2017;7(1). doi: <http://dx.doi.org/10.1016/j.kisu.2017.04.001>.
- [2] About chronic kidney disease. National Kidney Foundation. <https://www.kidney.org/atoz/content/about-chronic-kidney-disease>. Updated February 15, 2017.
- [3] The Pharmaceutical Journal, PJ October 2017 online, online | DOI: 10.1211/PJ.2017.20203723.

The correct answer is: Hold ramipril and furosemide until vomiting and diarrhea resolve

Question 2

ID: 54387

Correct

Flag question

1 month later, EP visits her family physician presenting with a gout episode that started 2 days ago. The physician calls you for advice on prescribing an agent for acute gout management.

Your recommendation is:

Select one:

- Indomethacin 50 mg TID X
- Allopurinol 300 mg po daily X
- Prednisone 25 mg po daily ✓
- Febuxostat 40 mg daily X

Rose Wang (ID:113212) this answer is correct. This is the most appropriate option for EP, though she will require close monitoring of her blood sugars.

Correct

Marks for this submission: 1.0/1.0.

TOPIC: Chronic kidney disease**LEARNING OBJECTIVE:**

To understand how chronic kidney disease can complicate treating other health conditions.

BACKGROUND:

Chronic kidney disease (CKD) is defined by the presence of kidney damage or a decrease in kidney function lasting for at least three months. The first sign of CKD is often a reduction in creatinine clearance and/or proteinuria. The staging of CKD is as follows:

CKD Staging

Kidney Function Stage	eGFR (ml/min/1.73m ²)
G1 - normal or high	≥90
G2 – Mildly decreased	60 - 89
G3a – Mildly to moderately decreased	45 - 59
G3b – moderately to severely decreased	30 - 44
G4 – severely decreased	15 - 29
G5 – kidney failure	<15 or on dialysis

Albuminuria Stage	Albuminuria (mg/mmol)
A1	<3
A2	3 - 30
A3	>30

Other changes in bloodwork include:

- Decreased hemoglobin, hematocrit, and ferritin
- Decreased calcium
- Decreased bicarbonate (i.e. a shift towards metabolic acidosis)
- Increased phosphate
- Increased potassium

Symptoms often begin to appear at stage G3b. Symptoms initially are mild but can progress and become severe as kidney function continues to drop. Symptoms include:

- Confusion
- Lack of energy
- Pruritis
- Lack of appetite
- Edema
- Lack of urination
- Nausea (in severe CKD)

Causes of CKD

Primary Causes	Secondary Causes
Glomerulonephritis	Hypertension
Polycystic Kidney disease	Diabetes
Alport Syndrome	Acute kidney injury

Abnormal kidney development	Lupus
	Renal obstruction (e.g. kidney stones, benign prostate hypertrophy, tumour)
	Recurring urinary tract infections
	Certain medications (e.g. lithium)

RATIONALE:

Correct Answer:

- **Prednisone 25 mg po daily** - This is the most appropriate option for EP, though she will require close monitoring of her blood sugars.

Incorrect Answers:

- **Indomethacin 50 mg TID** - Non-steroidal anti-inflammatories are not recommended in chronic kidney disease as they increase the risk of kidney failure.
- **Allopurinol 300 mg po daily** - Allopurinol is not used to treat acute gout attacks, and this dose is unsafe for EP's kidney function.
- **Febuxostat 40 mg daily** - Febuxostat is used for chronic gout prevention, it does not play a role in acute gout attacks.

TAKEAWAY KEY POINTS:

CKD treatment is complicated on its own, but it also complicates the treatment of other health conditions as some medications are contraindicated and others require dose adjustments in CKD.

REFERENCE:

[1] KDIGO 2017 clinical practice guideline update for the diagnosis, evaluation, prevention, and treatment of chronic kidney disease – mineral and bone disorder (CKD-MBD). *Kidney International Supplements*. 2017;7(1). doi: <http://dx.doi.org/10.1016/j.kisu.2017.04.001>.

[2] About chronic kidney disease. National Kidney Foundation. <https://www.kidney.org/atoz/content/about-chronic-kidney-disease>. Updated February 15, 2017.

The correct answer is: Prednisone 25 mg po daily

Question 3

ID: 54388

Correct

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EP presents to the kidney care clinic 3 months later feeling drowsy and very lethargic.

Labs:

- Creatinine - 570 mmol/L
- Creatinine clearance based on Cockcroft-Gault is 21 mL/min
- eGFR - 17 mL/min/1.73 m²

A medication reconciliation is done during the clinic visit. In addition to EP's previous medications, she was recently started on morphine sustained release 15 mg bid and gabapentin 200 mg po OD for pain in her feet and back pain.

The most likely reason for EP's symptoms include:

Select one:

- a. Accumulation of long-acting metabolite of analgesic ✓
- b. Worsening renal function due to disease progression ✗
- c. Gabapentin dose is too high for EP's renal function ✗
- d. EP is experiencing a hypoglycemic episode ✗

Rose Wang (ID:113212) this answer is correct. Morphine metabolites accumulates in chronic kidney dysfunction.

Correct

Marks for this submission: 1.0/1.0.

TOPIC: Chronic kidney disease

LEARNING OBJECTIVE:

Opioid use requires careful consideration in people with chronic kidney disease because the drug and metabolites of many opioids are renally cleared.

BACKGROUND:

Chronic kidney disease (CKD) is defined by the presence of kidney damage or a decrease in kidney function lasting for at least three months. The first sign of CKD is often a reduction in creatinine clearance and/or proteinuria. The staging of CKD is as follows:

CKD Staging

Kidney Function Stage	eGFR (ml/min/1.73m ²)
G1 - normal or high	≥90
G2 – Mildly decreased	60 - 89
G3a – Mildly to moderately decreased	45 - 59
G3b – moderately to severely decreased	30 - 44
G4 – severely decreased	15 - 29
G5 – kidney failure	<15 or on dialysis

When treating non-neuropathic pain in someone with CKD, the non-opioid options are limited as non-steroidal anti-inflammatories are contraindicated. For this reason, it is important to know which opioids are safe and which can accumulate in renal dysfunction.

Opioid use in CKD

Opioid	Morphine milligram equivalent (MME)	Notes
Tramadol	0.1	<ul style="list-style-type: none"> Renal clearance: 30% Exposure to potent active metabolites is increased by 20-40% Maximum 100 mg BID in CKD (CrCl <30 mL/min) Maximum 50 mg BID in dialysis
Buprenorphine	10	<ul style="list-style-type: none"> Renal clearance: 30% Weak active metabolite (norbuprenorphine) Safe for advanced CKD and dialysis; no dose reduction suggested at this time
Fentanyl	Depends on the route of administration	<ul style="list-style-type: none"> No clinically significant accumulation in CKD
Codeine	0.15	<ul style="list-style-type: none"> Renal clearance: 90% (metabolites), 10% (inactive parent drug) Accumulation of metabolites can lead to serious adverse effects (e.g. severe lethargy, respiratory depression, and severe hypotension) The risk of severe side effects increases in ultrarapid metabolizers of CYP2D6 Avoid in CKD
Tapentadol	0.4	<ul style="list-style-type: none"> Renal clearance: 99% No dose adjustment needed for CrCl ≥30 mL/min Not recommended for CrCl <30 mL/min
Morphine	1	<ul style="list-style-type: none"> Avoid in CKD with CrCl <30 mL/min and dialysis due to accumulation of active metabolites
Oxycodone	1.5	<ul style="list-style-type: none"> Parent compound and metabolites are substantially renally excreted May be used in CKD if monitored closely but is considered a second-line agent Dose adjustment is recommended in CKD
Oxymorphone	3	<ul style="list-style-type: none"> For patients with prior opioid use and CrCl <50 mL/min, use a 50% dose reduction May titrate dose if needed with close monitoring
Methadone	3	<ul style="list-style-type: none"> Methadone undergoes extensive biotransformation and is then excreted renally and via feces No dose adjustment for CKD

Hydromorphone

4

- Accumulation of active metabolite can cause neuroexcitatory symptoms (e.g. myoclonus, delirium and seizures)
- Dose adjustment is required in CKD:
 - Hydromorphone exposure after a 4 mg oral dose is doubled with a CrCl of 40 – 60 mL/min, and tripled with CrCl <30 mL/min.

RATIONALE:**Correct Answer:**

- **Accumulation of long-acting metabolite of analgesic** - Morphine metabolites accumulates in chronic kidney dysfunction.

Incorrect Answers:

- **Gabapentin dose is too high for EP's renal function** - Gabapentin requires dose adjustment with reduced kidney function, but this is an appropriate dose for EP.
- **EP is experiencing a hypoglycemic episode** - There is no indication that EP is currently experiencing hypoglycemia.
- **Worsening renal function due to disease progression** - This is not the most likely cause for EP's symptoms.

TAKEAWAY KEY POINTS:

Pain medication options are limited as kidney dysfunction worsens; it is important to know which opioids are safe in CKD and which should be avoided.

REFERENCE:

- [1] KDIGO 2017 clinical practice guideline update for the diagnosis, evaluation, prevention, and treatment of chronic kidney disease – mineral and bone disorder (CKD-MBD). *Kidney International Supplements*. 2017;7(1). doi: <http://dx.doi.org/10.1016/j.kisu.2017.04.001>.
- [2] About chronic kidney disease. National Kidney Foundation. <https://www.kidney.org/atoz/content/about-chronic-kidney-disease>. Updated February 15, 2017.
- [3] Pham PC, et al. 2017 update on pain management in patients with chronic kidney disease. *Clinical Kidney Journal*. 2017;10(5):688-697. doi: <https://doi.org/10.1093/ckj/sfx080>.

The correct answer is: Accumulation of long-acting metabolite of analgesic

Question 4

ID: 54390

Correct

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EP will be starting dialysis. Which of the following statement(s) is correct in regards to her dialysis treatment?

Select one:

- a. EP's drug doses do not need to be adjusted after starting dialysis treatment ✗
- b. Drug administration time may need to be adjusted around hemodialysis treatment ✓
- c. EP may be at a lower risk of drug toxicity when she starts dialysis treatment ✗
- d. Hemodialysis and peritoneal dialysis require the same drug dose adjustments ✗

Rose Wang (ID:113212) this answer is correct. Hemodialysis removes certain drugs abruptly from the body, and so administration time of these drugs is important.

Correct

Marks for this submission: 1.0/1.0.

TOPIC: Chronic kidney disease**LEARNING OBJECTIVE:**

To understand how dialysis can affect medication.

BACKGROUND:

Chronic kidney disease (CKD) is defined by the presence of kidney damage or a decrease in kidney function lasting for at least three months. The first sign of CKD is often a reduction in creatinine clearance and/or proteinuria. The staging of CKD is as follows:

CKD Staging

Kidney Function Stage	eGFR (ml/min/1.73m ²)
G1 - normal or high	≥90
G2 – Mildly decreased	60 - 89
G3a – Mildly to moderately decreased	45 - 59

G3b – moderately to severely decreased	30 - 44
G4 – severely decreased	15 - 29
G5 – kidney failure	<15 or on dialysis

Dialysis initiation is recommended if one or more of the following occur and cannot be controlled with less invasive interventions:

- Signs of kidney failure begin (e.g. acid-base irregularities, severe pruritis)
- Inability to control volume or blood pressure
- Progressive deterioration in nutritional status due to dietary intervention
- Mental impairment

GFR is usually around 5 - 10 ml/min/1.73 m² by the time these symptoms are severe enough to require dialysis.

There are two types of dialysis:

Hemodialysis

- A fistula is formed by surgically connecting an artery to a vein in the patient's forearm or arm
- Blood is pumped out of the body, through a dialysate which removes waste from the blood, then the filtered blood is pumped back into the body
- Hemodialysis is efficient so it is done approximately 3 times per week for a few hours at a time, but requires the patient to come to the dialysis clinic

Peritoneal dialysis

- Dialysate is pumped into the peritoneal cavity, waste is pulled into the dialysate, and then this dialysate is drained from the body
- This process can be done over several hours during the day (continuous ambulatory peritoneal dialysis) or overnight (continuous cycler-assisted peritoneal dialysis), but it has to be done every single day

The two types of dialysis use different filtration systems and have different potencies at filtering the blood; for this reason, drug doses are adjusted differently depending on the type of dialysis administered.

RATIONALE:

Correct Answer:

- **Drug administration time may need to be adjusted around hemodialysis treatment** - Hemodialysis removes certain drugs abruptly from the body, and so administration time of these drugs is important.

Incorrect Answers:

- **EP's drug doses do not need to be adjusted after starting dialysis treatment** - The same way certain drugs require dose adjustment in chronic kidney disease, some drugs require dose adjusting during dialysis.
- **EP may be at a lower risk of drug toxicity when she starts dialysis treatment** - EP may actually be at higher risk of drug toxicity as people on dialysis have minimal kidney function.
- **Dose adjustments vary depending on the type of dialysis administered** - Dose adjustments vary depending on the type of dialysis administered.

TAKEAWAY KEY POINTS:

Medication management during dialysis is complex as dose adjustments differ based on the type of dialysis administered and, for some drugs, it is unknown if dose adjustments are required.

REFERENCE:

- [1] KDIGO 2012 clinical practice guidelines for the evaluation and management of chronic kidney disease. Kidney International Supplements. 2013;3(1). doi: 10.1038/kisup.2012.73.
- [2] About chronic kidney disease. National Kidney Foundation. <https://www.kidney.org/atoz/content/about-chronic-kidney-disease>. Updated February 15, 2017.
- [3] Smyth B, Jones C, Saunders J. Prescribing for patients on dialysis. Aust Prescr. 2016;39(1):21-24. doi:10.18773/austprescr.2016.008.

The correct answer is: Drug administration time may need to be adjusted around hemodialysis treatment

Question 5

ID: 54411

Incorrect

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Which of the following chronic kidney disease drugs do **NOT** commonly cause nausea?

Select one:

- a. Calcium Carbonate X
- b. Sodium polystyrene sulfonate X
- c. Calcitriol ✓
- d. Ferrous X

Incorrect

Marks for this submission: 0.0/1.0.

TOPIC: Chronic kidney disease**LEARNING OBJECTIVE:**

To understand the definition of chronic kidney disease and common treatments for disease complications.

BACKGROUND:

Chronic kidney disease (CKD) is defined by the presence of kidney damage or a decrease in kidney function lasting for at least three months. The first sign of CKD is often a reduction in creatinine clearance and/or proteinuria. The staging of CKD is as follows:

CKD Staging

Kidney Function Stage	eGFR (ml/min/1.73m ²)
G1 - normal or high	≥90
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G3a – Mildly to moderately decreased	45 - 59
G3b – moderately to severely decreased	30 - 44
G4 – severely decreased	15 - 29
G5 – kidney failure	<15 or on dialysis

Albuminuria Stage	Albuminuria (mg/mmol)
A1	<3
A2	3 - 30
A3	>30

Other changes in bloodwork include:

- Decreased hemoglobin, hematocrit, and ferritin
- Decreased calcium
- Decreased bicarbonate (i.e. shift towards metabolic acidosis)
- Increased phosphate
- Increased potassium

Oral vitamin D₃ is inactive. It is biotransformed by both the liver and kidneys to become its active form. As kidney function decreases, so does its ability to biotransform vitamin D. As a result, calcitriol is given; this is the kidney-transformed form of vitamin D.

Calcium carbonate supplements are used in CKD patients for 2 reasons: to increase serum calcium level and to prevent absorption of dietary phosphate when the supplement is administered with food.

Anemia is common in CKD, especially as the disease progresses. Iron supplements such as ferrous fumarate are often prescribed as a treatment for the anemia.

Sodium polystyrene sulfonate prevents potassium absorption by binding the potassium in the intestine and causing its excretion via feces.

RATIONALE:**Correct Answer:**

- Calcitriol** - Calcitriol is a form of active vitamin D, it is not known to cause nausea.

Incorrect Answers:

- Calcium Carbonate** - Nausea is a common side effect of calcium carbonate.
- Sodium polystyrene sulfonate** - Nausea is a common side effect of sodium polystyrene sulfonate.
- Ferrous fumarate** - Nausea is a common side effect of ferrous fumarate.

TAKEAWAY/KEY POINTS:

There are treatment options to regulate every electrolyte disturbance brought on by CKD.

REFERENCE:

[1] KDIGO 2012 clinical practice guidelines for the evaluation and management of chronic kidney disease. Kidney International Supplements. 2013;3(1). doi: 10.1038/kisup.2012.73.

[2] KDIGO 2017 clinical practice guideline update for the diagnosis, evaluation, prevention, and treatment of chronic kidney disease – mineral and bone disorder (CKD-MBD). *Kidney International Supplements*. 2017;7(1). doi: <http://dx.doi.org/10.1016/j.kisup.2017.04.001>.

The correct answer is: Calcitriol

Question 6

ID: 54412

Incorrect

 Flag question

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Which of the following statements is correct regarding the management of anemia using erythropoietin-stimulating agent (ESA) therapy?

Select one:

- Hemoglobin should be <100 g/L in order to qualify for ESA therapy ✓
- Vitamin B12 supplementation provides greater efficacy ✗
- Target hemoglobin level is >120 g/L during ESA treatment ✗
- Hemoglobin should be monitored every two months while on ESA ✗

Rose Wang (ID:113212) this answer is incorrect. ESA targets hemoglobin level of up to 115 g/L.

Incorrect

Marks for this submission: 0.0/1.0.

TOPIC: Chronic kidney disease

LEARNING OBJECTIVE:

Chronic kidney disease can lead to anemia, partially due to reduced production of erythropoietin. Erythropoietin-stimulating agents (ESA) are sometimes used to correct severe anemias.

BACKGROUND:

Anemia is diagnosed as having a hemoglobin level less than 130 g/L (males) or less than 120 g/L (females). It can be caused by a lack of iron stores, lack of folate, and/or lack of vitamin B12.

First-line treatment for anemia is oral iron supplements (and folate and vitamin B12 if needed). If oral supplements are insufficient, then IV iron is a second-line treatment. ESA is recommended if hemoglobin (Hb) is <100 g/L and iron is ineffective in raising Hb level.

While on ESA therapy, Hb should ideally increase by 10 - 20 g/L each month, with a target Hb of up to 115 g/L, as this is the most common target used in ESA studies. Hb should not increase faster than 20 g/L as it is believed that such a rapid increase can cause severe hypertension. Studies have not shown improved outcomes with Hb >120 g/L. In addition, Hb >130 g/L while on ESA treatment may increase the risk of hypertension and stroke.

Potential causes for subtherapeutic response to ESA include:

- Cardiovascular disease
- Female Gender
- Inflammatory state
- Iron deficiency
- Overweight

RATIONALE:

Correct Answer:

- **Hemoglobin should be <100 g/L in order to qualify for ESA therapy** - ESA is reserved for severe anemia as it is associated with significant risks such as severe hypertension and stroke.

Incorrect Answers:

- **Vitamin B12 supplementation provides greater efficacy** - Vitamin B12 is not required to increase ESA efficacy.
- **Target hemoglobin level is >120 g/L during ESA treatment** - ESA targets hemoglobin level of up to 115 g/L.
- **Hemoglobin should be monitored every two months while on ESA** - Hemoglobin should be monitored at least once monthly while on ESA therapy.

TAKEAWAY/KEY POINTS:

ESA is associated with serious risks and is therefore reserved for severe anemia and requires close monitoring of the patient.

REFERENCE:

[1] KDIGO clinical practice guideline for anemia in chronic kidney disease. *KDIGO*. 2012;2(4). doi: 10.1038/kisup.2012.37.

The correct answer is: Hemoglobin should be <100 g/L in order to qualify for ESA therapy

Question 7

ID: 54413

Incorrect

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Which one of the following is the most likely to cause acute kidney injury in patients with underlying chronic kidney disease?

Select one:

- a. Morphine 
- b. Gentamicin 
- c. Ciprofloxacin 
- d. Nitrofurantoin 

Rose Wang (ID:113212) this answer is incorrect. Only rare reports of acute kidney injury have been reported with ciprofloxacin.

Incorrect

Marks for this submission: 0.0/1.0.

TOPIC: Chronic kidney disease**LEARNING OBJECTIVE:**

Chronic kidney disease is a risk factor for acute kidney injury. Certain medications can also negatively impact the kidneys, therefore increasing the risk of acute kidney injury.

BACKGROUND:

Acute kidney injury (AKI) occurs when there is a rapid decrease in kidney function. AKI can be classified based on where the damage or impairment is occurring in the kidney:

- *Pre-renal AKI* occurs when there is hypoperfusion of the kidney (the most common cause of AKI)
- *Intrinsic AKI* occurs when there is damage or impairment within the kidney
- *Post-renal AKI* occurs when a severe blockage beyond the kidney (e.g. in the ureter) causes waste buildup in the kidney

Possible causes of AKI

Impairment Location	Possible causes of AKI
Pre-renal AKI	<ul style="list-style-type: none"> • Hypovolemia • Increased vascular resistance • Reduced cardiac function • Systemic vasodilation
Intrinsic AKI	<ul style="list-style-type: none"> • Bilateral renal artery stenosis • Infection • Immune system dysfunction (e.g. lupus, IgA glomerulonephritis) • Nephrotoxic drugs
Post-renal AKI	<ul style="list-style-type: none"> • Blood clots • Improperly placed catheter • Kidney stones (nephrolithiasis) • Urogenital cancers

Medications can cause AKI via several mechanisms:

- Changing the blood flow rate within the glomerulus
 - e.g. nonsteroidal anti-inflammatory drugs (NSAIDs), angiotensin-converting enzyme inhibitors (ACEi)
- Inflammation within the glomerulus
 - e.g. NSAIDs, propylthiouracil
- Acute interstitial nephritis due to drug binding to antigens in the kidney
 - e.g. fluoroquinolones, trimethoprim/sulfamethoxazole, aminoglycosides, diuretics
- Drug crystalizes and causes a urinary outflow blockage
 - e.g. ciprofloxacin, methotrexate, sulfamethoxazole
- Rhabdomyolysis
 - e.g. statins, benzodiazepines

- Inducing clots within small vessels of the kidney
 - e.g. clopidogrel, cyclosporine

RATIONALE:**Correct Answer:**

- Gentamicin** - Aminoglycosides are commonly associated with nephrotoxicity.

Incorrect Answers:

- Morphine** - Morphine toxicity increases in severe chronic kidney disease due to accumulation, but it is not known to cause acute kidney injury.
- Ciprofloxacin** - Only rare reports of acute kidney injury have been reported with ciprofloxacin.
- Nitrofurantoin** - Nitrofurantoin is not known to cause acute kidney injury.

TAKEAWAY/KEY POINTS:

Several medications are known to cause acute kidney injury; their risk versus benefit should be thoroughly evaluated when being prescribed to an individual with chronic kidney disease.

REFERENCE:

- [1] KDIGO clinical practice guidelines for acute kidney injury. *Kidney International Supplements*. 2012;2(1). doi:10.1038/kisup.2012.1.
- [2] Makris K, Spanou L. Acute Kidney Injury: Definition, Pathophysiology and Clinical Phenotypes. *Clin Biochem Rev*. 2016;37(2):85-98.
- [3] Naughton C. Drug-induced nephrotoxicity. *Am Fam Physician*. 2008;78(6):743-750.

The correct answer is: Gentamicin

Question 8

ID: 55443

Correct

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A female patient with chronic kidney disease is chronically fatigued. The patient is receiving erythropoietin-stimulating agent (ESA) therapy and has a hemoglobin of 113 g/L. A nurse is inquiring about targeting a higher hemoglobin to help improve the patient's fatigue. The most appropriate response is:

Select one:

- a. In patients receiving ESA, ✓ the risk of stroke increases with higher hemoglobin levels Rose Wang (ID:113212) this answer is correct. ESA-induced hemoglobin above 115 - 120 g/L is associated with little to no improvement in quality of life but an increase risk of hypertension and stroke.
- b. In patients receiving ESA, the risk of nausea and vomiting is higher with higher hemoglobin levels ✗
- c. In patients receiving ESA, the risk of allergic reaction increases with higher hemoglobin levels ✗
- d. A higher hemoglobin requires more frequent monitoring to ensure target level isn't surpassed ✗

Correct

Marks for this submission: 1.0/1.0.

TOPIC: Chronic kidney disease**LEARNING OBJECTIVE:**

Chronic kidney disease can lead to anemia, partially due to reduced production of erythropoietin. Erythropoietin-stimulating agents (ESA) are sometimes used to correct severe anemias.

BACKGROUND:

Anemia is diagnosed as having a hemoglobin level less than 130 g/L (males) or less than 120 g/L (females). It can be caused by a lack of iron stores, lack of folate, and/or lack of vitamin B12.

First-line treatment for anemia is oral iron supplements (and folate and vitamin B12 if needed). If oral supplements are insufficient, then IV iron is a second-line treatment. ESA is recommended if hemoglobin (Hb) is <100 g/L and iron is ineffective in raising Hb level.

While on ESA therapy, Hb should ideally increase by 10 - 20 g/L each month, with a target Hb of up to 115 g/L, as this is the most common target used in ESA studies. Hb should not increase faster than 20 g/L as it is believed that such a rapid increase can cause severe hypertension. Studies have not shown improved outcomes with Hb >120 g/L. In addition, Hb >130 g/L while on ESA treatment may increase the risk of hypertension and stroke.

Potential causes for subtherapeutic response to ESA include:

- Cardiovascular disease
- Female Gender
- Inflammatory state
- Iron deficiency

- Overweight

RATIONALE:

Correct Answer:

- In patients receiving ESA, the risk of stroke increases with higher hemoglobin levels - ESA-induced hemoglobin above 115 - 120 g/L is associated with little to no improvement in quality of life but an increase risk of hypertension and stroke.

Incorrect Answers:

- In patients receiving ESA, the risk of nausea and vomiting with higher hemoglobin levels - This is not true.
- In patients receiving ESA, the risk of allergic reaction increases with higher hemoglobin levels - This is not true.
- A higher hemoglobin requires more frequent monitoring to ensure target level isn't surpassed - This is not the most accurate response.

TAKEAWAY/KEY POINTS:

ESA is associated with serious risks and is therefore reserved for severe anemia and requires close monitoring of the patient.

REFERENCE:

[1] KDIGO clinical practice guideline for anemia in chronic kidney disease. *KDIGO*. 2012;2(4). doi: 10.1038/kisup.2012.37.

The correct answer is: In patients receiving ESA, the risk of stroke increases with higher hemoglobin levels

Question 9

ID: 54410

Correct

 Flag question

 Send Feedback

DK is an 81 year old female admitted to the hospital with an elevated serum potassium of 5.8 mmol/L and subsequent cardiac arrhythmia. She has a history of chronic kidney disease and hypertension.

DK was diagnosed with a UTI 3 days ago. She was prescribed Septra® (sulfamethoxazole/trimethoprim) 800 mg/160 mg BID.

Her home medications include:

- perindopril 8 mg daily
- furosemide 40 mg BID; and
- cetirizine 20 mg once daily

What is the most reasonable explanation for DK's hyperkalemia and subsequent arrhythmia?

Select one:

- a. DK is non-compliant with her renal diet and eats food high in potassium 
- b. DK is likely experiencing hyperkalemia secondary to perindopril and Septra® therapy 
- c. DK is likely experiencing hyperkalemia secondary to perindopril and furosemide therapy 
- d. DK is likely experiencing hyperkalemia secondary to furosemide and cetirizine therapy 

Rose Wang (ID:113212) this answer is correct. Perindopril increases serum potassium, as does trimethoprim in Septra®.

Correct

Marks for this submission: 1.0/1.0.

TOPIC: Chronic kidney disease

LEARNING OBJECTIVE:

To identify the signs and causes of hyperkalemia as it can be a complication of renal dysfunction.

BACKGROUND:

Potassium is an electrolyte that is critical for proper functioning of smooth muscles, skeletal muscles, the heart, and nerves.

Normal potassium level is between 3.3 - 5.1 mmol/L. There isn't evidence to suggest the exact potassium level at which intervention is required. However, it is generally accepted that potassium ≥ 5.5 mmol/L requires non-pharmacological treatment and potassium ≥ 6.0 mmol/L requires pharmacological treatment.

Symptoms of hyperkalemia include:

- Muscle weakness
- Flaccid paralysis
- Partial or complete blockage of the intestine (ileus)
- Changes in ECG
 - Tall peaked T wave
 - Loss of P wave with tall peaked T wave

- Widened QRS with tall T wave

Causes of Hyperkalemia

Lab work issue	Laboratory error Repeated clenching of the fist while blood is drawn Lysis of blood sample
Medication	Angiotensin-converting enzyme inhibitors (ACEi) Angiotensin II receptor blockers Azole antifungals Beta-blockers Cyclosporine Digoxin (at toxic levels) Glucose infusion Insulin deficiency Nonsteroidal anti-inflammatory drugs (NSAIDs) Potassium-sparing diuretics (amiloride, eplerenone, spironolactone, triamterene) Potassium supplements Tacrolimus Trimethoprim
Medical conditions	Chronic kidney dysfunction Renal failure Renal hypoperfusion Hypoaldosteronism

RATIONALE:

Correct Answer:

- **DK is likely experiencing hyperkalemia secondary to perindopril and Septra® therapy** - Perindopril increases serum potassium, as does trimethoprim in Septra®.

Incorrect Answers:

- **DK is non-compliant with her renal diet and eats food high in potassium** - This may be true, but the question does not provide any information about DK's diet.
- **DK is likely experiencing hyperkalemia secondary to perindopril and furosemide therapy** - Furosemide actually reduces serum potassium level.
- **DK is likely experiencing hyperkalemia secondary to furosemide and cetirizine therapy** - Neither of these medications are associated with hyperkalemia.

TAKEAWAY/KEY POINTS:

There is a long list of medications that can induce hyperkalemia and bloodwork should be done at regular intervals to monitor potassium levels.

REFERENCE:

[1] Hollander-Rodriguez JC, Calvert JF. Hyperkalemia. *Am Fam Physician*. 2006;73(2):283-290.
 [2] Elliot MJ, Ronksley PE, Clase CM, Ahmed SJ, Hemmelgarn BR. *Can Med Assoc J*. 2010;182(15):1631-1635. doi:<https://doi.org/10.1503/cmaj.100461>.

The correct answer is: DK is likely experiencing hyperkalemia secondary to perindopril and Septra® therapy

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